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QUALITY OF GROUND WATER IN SHALLOW WELLS IN AGRICULTURAL AREAS OF HAYWOOD, SHELBY, LAKE, AND OBION COUNTIES, TENNESSEE, JANUARY AND FEBRUARY 1988

Prepared in cooperation with the

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF CONSTRUCTION GRANTS AND LOANS

U.S. GEOLOGICAL SURVEY

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By Dorothea Barrows Withington

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By Dorothea Barrows Withington

ABSTRACT

There are sparse data on the impact of agricultural chemicals on ground-water quality in the state of Tennessee. Three areas have been chosen in West Tennessee for sampling ground water for nitrogen species and pesticides. These areas, located in Haywood, Shelby, Lake, and Obion Counties, are all areas of high intensity agriculture. Because of the importance of the surficial alluvial aquifer to domestic supply in West Tennessee, shallow wells at each site were sampled. Two sampling events were scheduled, in the winter and in the spring, to document seasonal variation in concentrations of nutrients and pesticides. Preliminary results from the first sampling event indicate a range of concentrations of nitrite plus nitrate as nitrogen from less than 0.1 to 7.8 milligrams per liter. The results from analyses for triazine pesticide show all concentrations below the analytical detection limit.

INTRODUCTION

Almost one-half of Tennessee's total land area is devoted to farming. High intensity agricultural areas include much of West Tennessee, which is noted for large row cropping operations. In Lake County, located in the northwest corner of the State, 81 percent of the land is under cultivation; mostly soybeans and corn. Application of pesticides and chemical fertilizers, necessary for economic returns in modern agriculture, can degrade ground-water quality.

Nitrogen fertilizers are added to soils in large amounts, and it has been estimated that up to 60 percent of the nitrogen in these compounds may enter the ground water. Both the Tennessee Department of Public Health (1977) and the U.S. Environmental Protection Agency (1986) have established a limit of 10 milligrams per liter nitrate (as nitrogen) as the maximum contaminant level for finished drinking water. In areas of soybean cultivation, 48 percent of harvested acreage is fertilized, while in cotton areas, 100 percent of the cultivated land is fertilized. For the past 39 years (1946-85), over 735,000 tons of fertilizer have been applied on Tennessee soil.

Pesticides in use include a spectrum of herbicides, insecticides, and other chemical agents. In West Tennessee, triazine herbicides are the principal pesticides (Steven Burgess, Agricultural Extension Service, oral commun., 1988). In cotton-growing areas, methyl parathion (an organophosphorous insecticide) is used for control of boll weevils.

The U.S. Geological Survey, in cooperation with the Division of Construction Grants and Loans of the Tennessee Department of Health and Environment, is conducting a reconnaissance of the impact of agricultural chemicals on ground-water quality. The potential impact is of concern because the main source of water in rural areas for domestic supply is ground water. Selected wells in three areas have been sampled for nitrogen species and pesticides. Each site represents the major agricultural products of West Tennessee: cotton, soybeans, and corn.

Purpose and Scope

The purpose of this investigation is to describe the ground-water quality in the shallow alluvial aquifer in areas under active cultivation. Sampling will be conducted during periods prior to chemical application, and directly after the application of fertilizers and pesticides. This report describes the schedule of data collection as well as reports on the preliminary analyses on water-quality data collected during January and February 1988.

Previous Work

The U.S. Geological Survey has published pesticide data for bottom-material and surface-water samples for Tennessee (Gaydos, 1983; Robbins and others, 1985). To date, there have been no systematic studies statewide of pesticide concentrations in ground water.

Acknowledgments

The author would like to thank the various landowners who have provided access to their wells.

COLLECTION OF HYDROLOGIC DATA

Data-Collection Program

Sampling sites were chosen to represent the major agricultural practices of West Tennessee. These sites are located in Haywood, Shelby, Lake, and Obion Counties (fig. 1). Haywood County is the top county in Tennessee in cotton production, and also produces corn and soybeans. Shelby County produces mostly soybeans and cotton, while Lake County is ranked fifth in the state for soybean production (Tennessee Agricultural Statistics Service, 1987).

The sites in Shelby and Lake Counties were chosen because of ongoing hydrogeologic investigations by the U.S. Geological Survey and the consequent availability of shallow wells and water-quality data. Shallow domestic wells were selected for sampling in Haywood County. All wells sampled are in or near fields under active cultivation. A total of 20 wells will be sampled for this study; 7 wells in Haywood County, 6 wells in Lake County near Reelfoot Lake and one in Obion County, and 6 wells in Shelby County, on the Agricenter and Penal Farm (figs. 2-4). Well depths range from 17 to 90 feet below land surface (table 1), and all are screened in the upper alluvial aquifer.

Two sampling events were scheduled to bracket the growing season (Steven Burgess, Agricultural Extension Service, oral commun., 1987). Samples were collected in January and February 1988 when the land was fallow. Because the land was fallow and consequently no agricultural chemicals were applied, sampling during the January-February period provides information on background or persistent levels of these chemicals in ground water. Samples will be collected again during the period May to June 1988 directly following application of fertilizer and pesticides. During both sampling events, water temperature

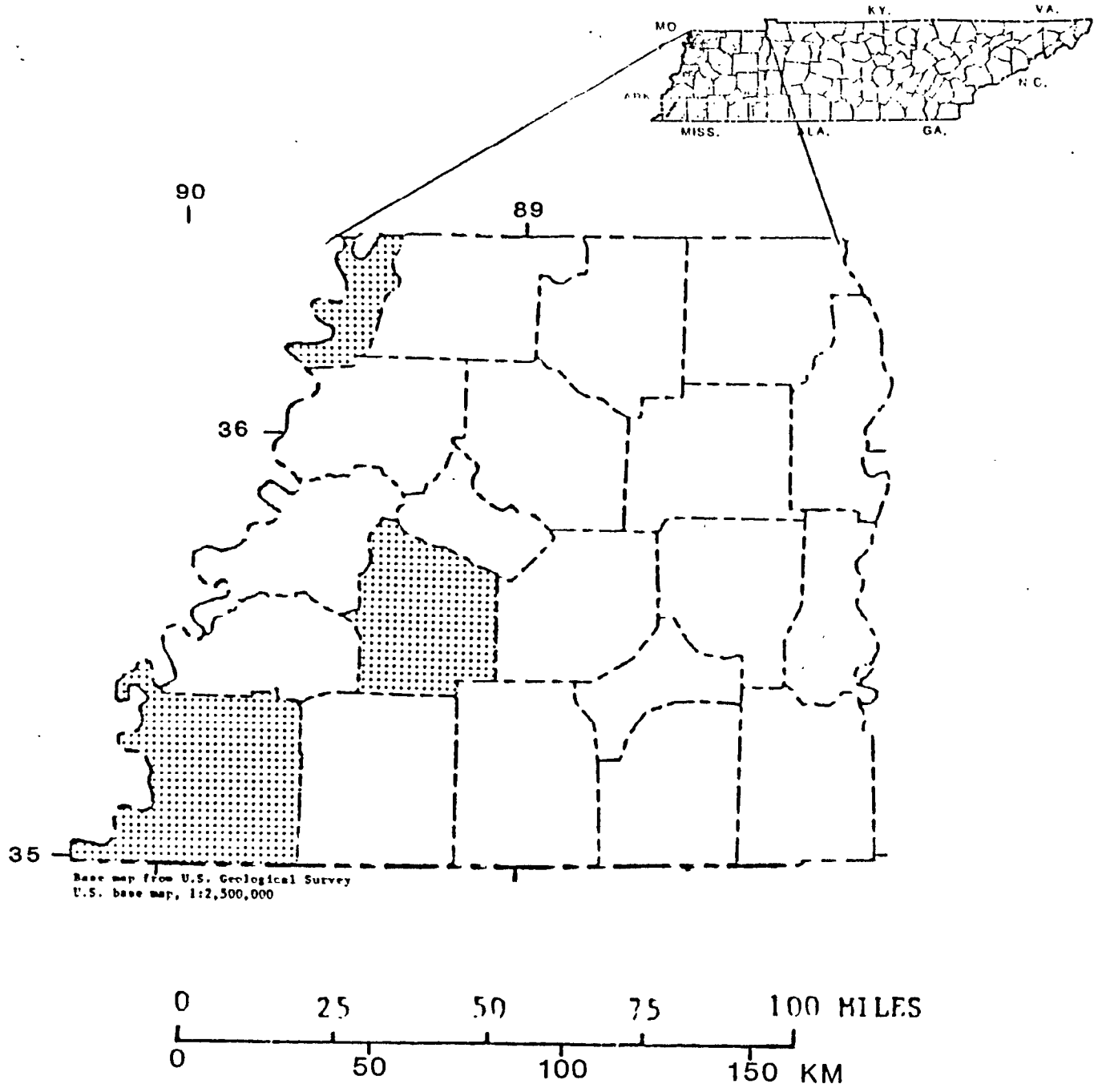

Figure 1.--Generalized location of the sampling areas in West Tennessee.

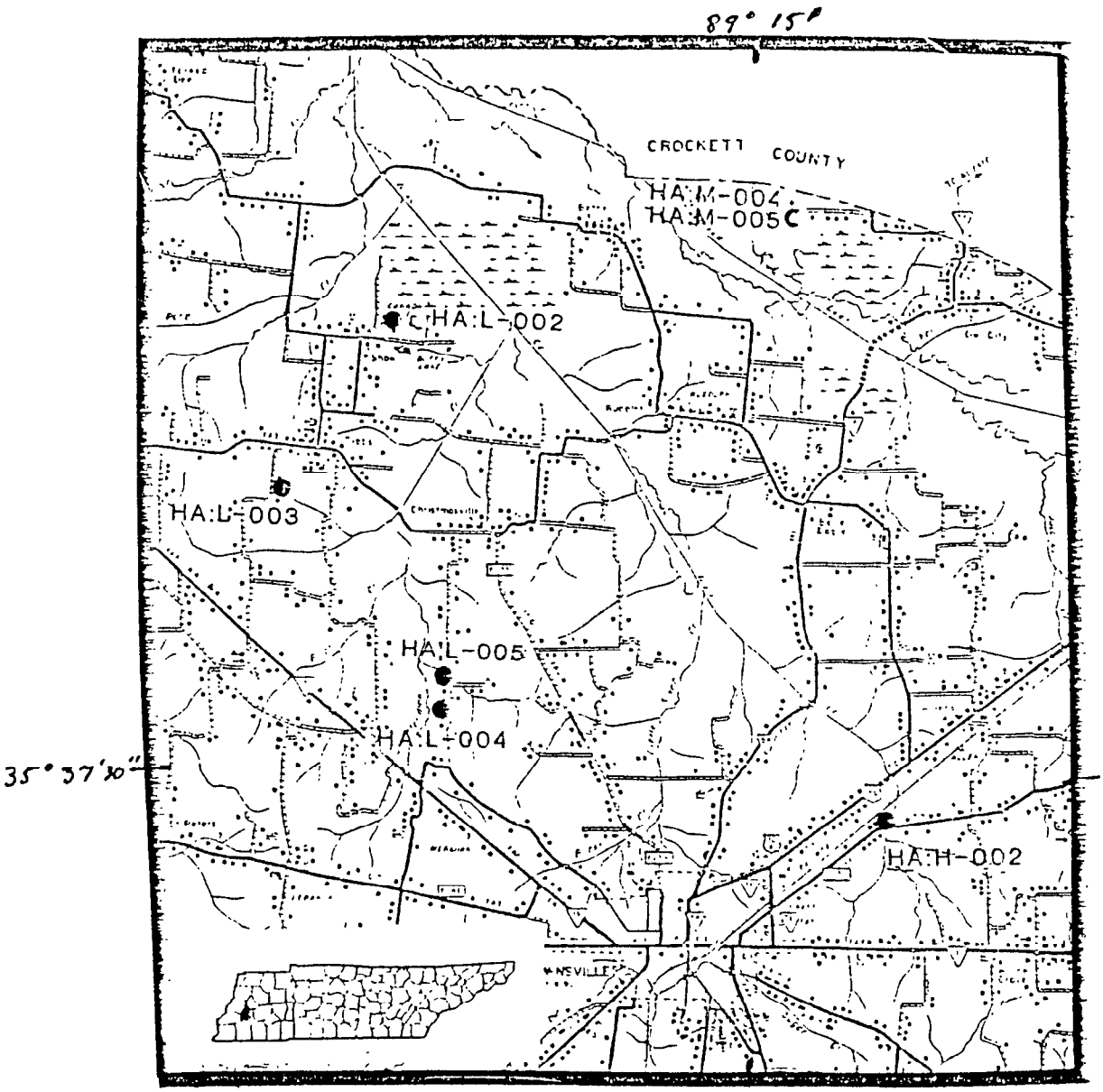

Figure 2.- Location of wells sampled in Haywood County.

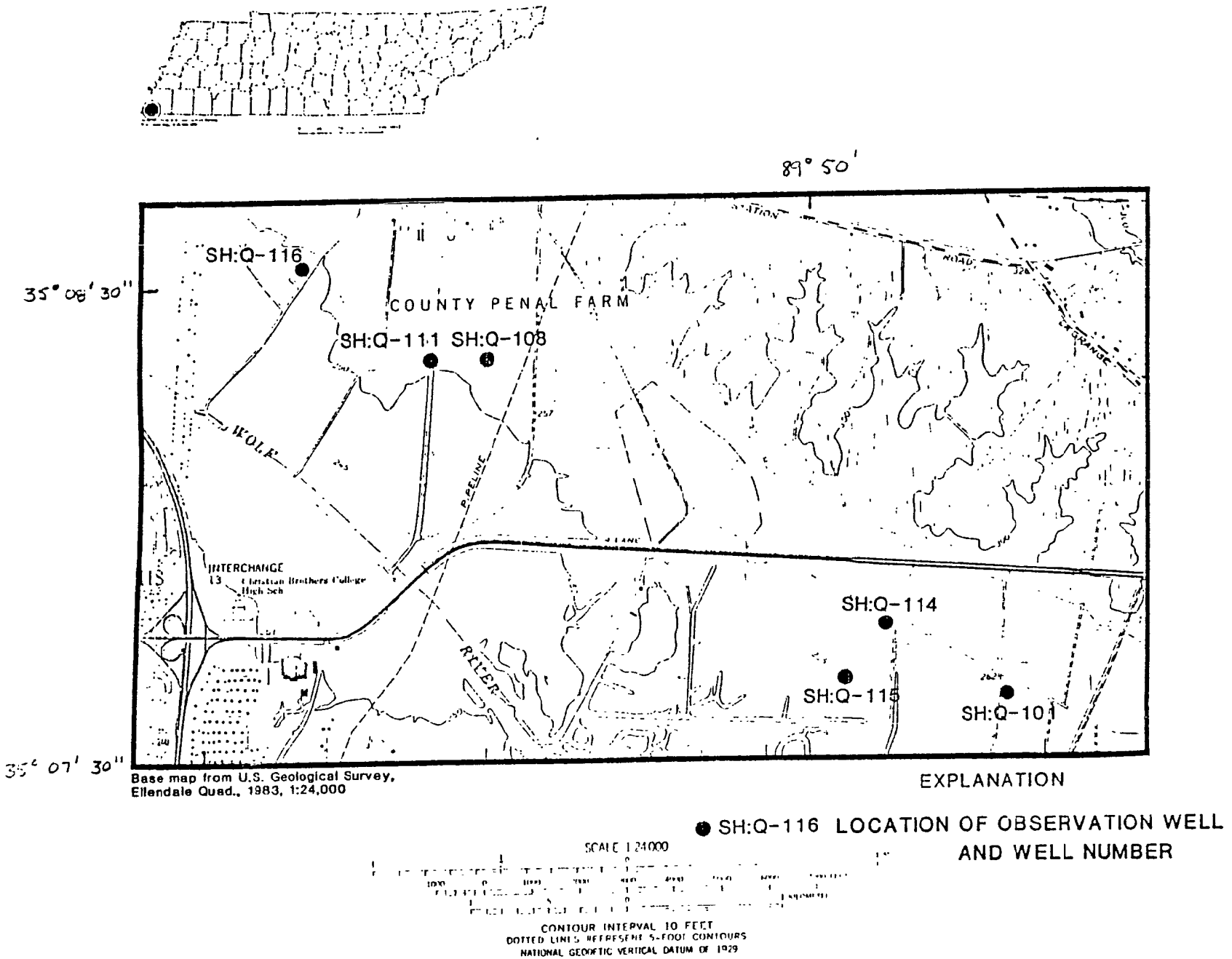

Figure 3.--Location of wells sampled in Shelby County.

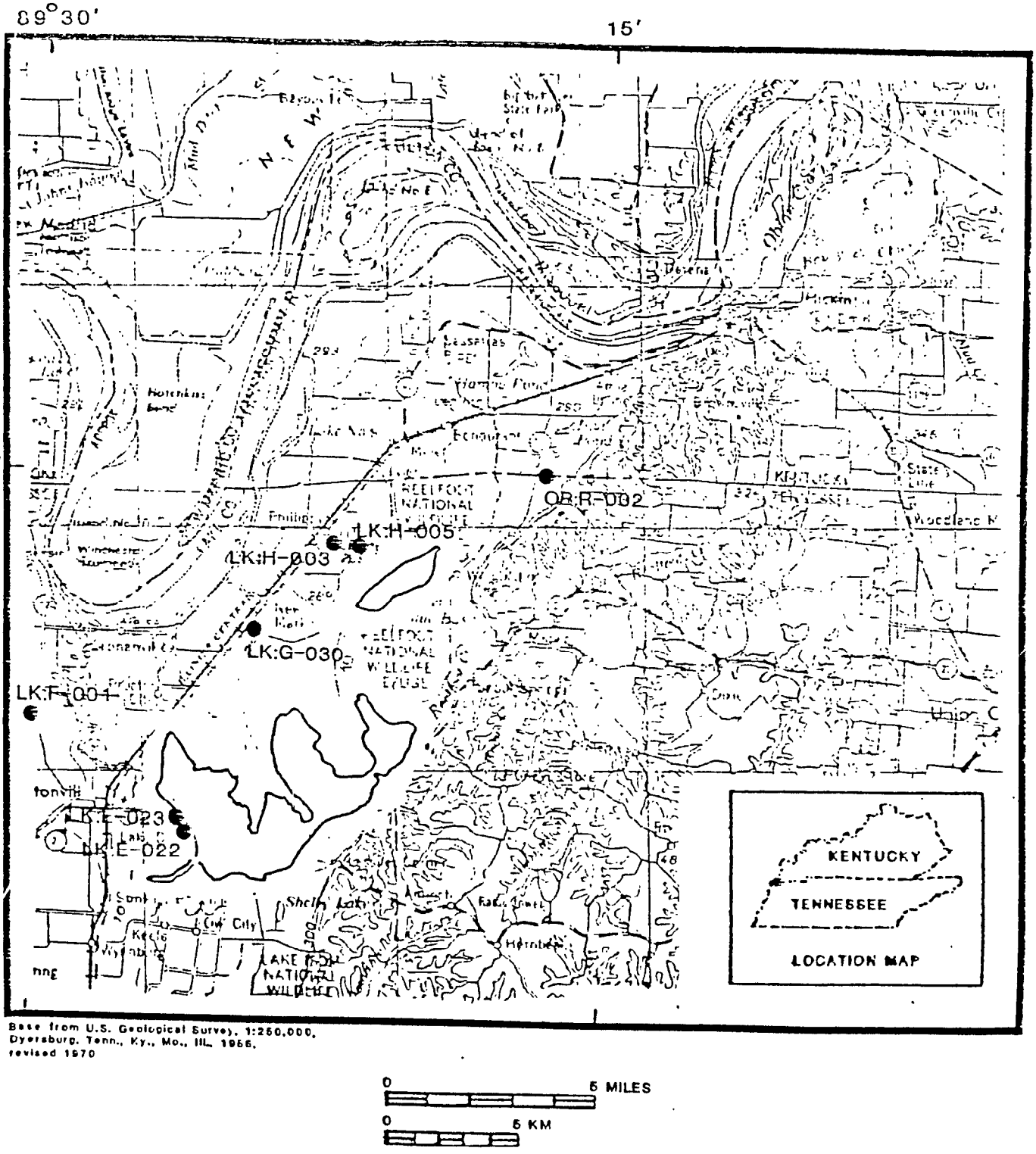

Figure 4.--Location of wells sampled in Lake and Obion Counties.

Table 1.--Locations and depths of wells, and summary of samples collected

[N = nitrogen species; H = triazine herbicides; I = organophosphorous insecticides]

Well Number	Latitude	Longitude	Depth	Samples Collected (Janaury and February 1988)
		HAYWOOD COUNTY		
HA:L-002	354319	0891947	30	N,H,I
HA:L-003	354133	0892127	60	N,H,I
HA:L-004	353855	0891903	90	N,H,I
HA:L-005	353756	0891907	90	N,H,I
HA:H-002	353706	0891255	50	N,H,I
HA:M-004	354449	0891334	60	N,H,I
HA:M-005	354451	0891337	22	N,H,I
		SHELBY COUNTY		
SH:Q-101	350741	0894909	38	N
SH:Q-108	350836	0895032	44	N,H
SH:Q-111	350838	0895113	43	N,H
SH:Q-114	350753	0894933	45	N
SH:Q-115	350745	0894945	54	N,H
SH:Q-116	350745	0895140	28	N,H
		LAKE AND OBION COUNTIES		
LK:E-022	362156	0892610	17	N,H
LK:E-023	362227	0892609	28	N,H
LK:F-001	362503	0892914	40	N,H
LK:G-030	362709	0892415	29	N,H
LK:G-031	362444	0892507	49	N,H
LK:H-003	362924	0892156	29	N,H
OB:R-002	363017	0891653	28	N,H

and specific conductance are measured, and all samples will be analyzed for triazine herbicides and nitrite plus nitrate as nitrogen. In addition, samples collected in Haywood County will be analyzed for organophosphorous insecticides (used for control of the boll weevil, Anthonomus Grandis).

Methods of Data Collection

Every effort was made to collect representative samples. At least five casing volumes were evacuated prior to sampling. The wells at the Agricenter and Penal Farm were sampled with a stainless steel bailer. Wells near Reelfoot Lake were sampled either with a bailer or a centrifugal pump. Access to the domestic wells in Haywood County was by hydrants or faucets on pressure systems. Pressure tanks were flushed until specific conductance stabilized to ensure a representative sample.

Water samples were analyzed by the U.S. Geological Survey lab in Arvada, Colorado. Analyses for total nitrite plus nitrate as nitrogen were performed on all samples using the cadmium-reduction method (Skougstad and others, 1979). Also, all the water samples were analyzed for total recoverable triazine herbicides using an acid extraction followed by gas chromatography (Wershaw and others, 1983). The seven samples from Haywood County will also be analyzed for total recoverable organophosphorous compounds, using hexane extraction and gas chromatography (Wershaw and others, 1983).

Some problems have been encountered during the initial sampling. The first batch of pesticide samples from Haywood County were ruined by the laboratory and will be resampled the week of April 18. The wells at the Agricenter in Shelby County could not be fully developed using a bailer, so only four of the six wells were sampled for triazine herbicides.

SUMMARY OF PRELIMINARY RESULTS

Concentrations of nitrite plus nitrate (as N) for 17 analyses range from less than 0.1 to 7.8 milligrams per liter, with a mean of 2.6 milligrams per liter (mg/L) (table 2). The limit of 10 mg/L was not exceeded (Tennessee Department of Public Health, 1977; U.S. Environmental Protection Agency, 1986). Six of the samples have concentrations greater than 3 mg/L, while four samples have concentrations greater than 5 mg/L. Evaluation of existing data of nitrate concentrations in the United States define concentrations of greater than 3 milligrams per liter as indicative of possible human input (National Water Summary, 1984). A preliminary study of nitrate concentration within the Tennessee Valley region shows that less than 5 percent of the wells sampled had concentrations greater than 3 mg/L (John Soileau, Tennessee Valley Authority, written commun., 1987).

Triazine herbicide concentrations for six samples, if present, were below detection limits (table 3). Analyses from wells Sh:Q-101, Sh:Q-108, Sh:Q-111, Lk:E-022, and Lk:E-023 will be available shortly.

Table 2.--Nitrogen concentrations in sampled wells

Station name	Date	Depth of well, total (feet) (72008)	Specific conductance (uS/cm) (00095)	Nitrogen, total (mg/L as N) (00600)	Nitrogen, ammonia total (mg/L as N) (00610)	Nitro-Gen,ammonia + organic total (mg/L as N) (00625)	Nitrogen, NO2+NO3 total (mg/L as N) (00630)
			HAYWOOD COUNTY				
HA:H-002	01-26-88	50.00	62	--	0.020	<0.20	0.900
HA:L-002	01-26-88	30.00	33	--	<0.010	<0.20	5.70
HA:L-003	01-26-88	60.00	24	--	<0.010	<0.20	3.10
HA:L-004	01-26-88	90.00	14	--	0.010	<0.20	1.40
HA:L-005	01-26-88	90.00	14	2.6	<0.010	0.20	2.40
HA:M-004	01-26-88	60.00	56	--	<0.010	<0.20	<0.100
HA:M-005	01-26-88	22.00	110	7.3	<0.010	0.30	7.00
			SHELBY COUNTY				
SH:Q-101	02-09-88	37.70	540	0.80	0.040	0.30	0.500
SH:Q-108	02-09-88	43.60	530	3.0	0.120	2.7	0.300
SH:Q-111	02-09-88	43.30	267	8.2	0.030	1.5	6.70
SH:Q-114	02-09-88	45.00	650	12	<0.010	3.7	7.80
SH:Q-115	02-09-88	54.20	540	--	0.100	0.60	<0.100
SH:Q-116	02-09-88	28.00	138		0.04	3.0	<0.100
			LAKE COUNTY				
LK:E-022	02-25-88	17.40	300	5.0	0.100	0.50	4.50
LK:E-023	02-25-88	27.60	750	--	0.850	0.60	<0.100
LK:F-001	02-24-88	40.00	750	--	0.810	1.0	<0.100
LK:G-030	02-25-88	28.70	750	2.0	0.430	1.8	0.200
LK:H-005	02-25-88	26.90	400	--	0.070	0.60	<0.100
LK:H-003	02-24-88	29.00	260	2.7	0.040	0.30	2.40
			OBION COUNTY				
OB:R-002	02-24-88	28.00	500	--	0.520	0.50	<0.100

Table 3.--Triazine herbicide concentrations in sampled wells

Station name	Date	Depth of well, total (feet) (72008)	Temperature water (deg C) (00010)	Specific conductance (uS/cm) (00095)	Propazine total (ug/L) (39024)	Trifluralin total recover (ug/L) (39030)
		HAYWOOD COUNTY				
HA:H-002	01-26-88	50.00	15.0	62	--	--
HA:L-002	01-26-88	30.00	14.0	33	--	--
HA:L-003	01-26-88	60.00	14.5	24	--	--
HA:L-004	01-26-88	90.00	15.0	14	--	--
HA:L-005	01-26-88	90.00	14.0	14	--	--
HA:M-004	01-26-88	60.00	16.0	56	--	--
HA:M-005	01-26-88	22.00	13.0	110	--	--
		SHELBY COUNTY				
SH:Q-101	02-09-88	37.70	16.0	540	--	--
SH:Q-108	02-09-88	43.60	15.0	530	--	--
SH:Q-111	02-09-88	43.30	15.0	267	--	--
SH:Q-114	02-09-88	45.00	16.0	650	<0.20	<0.20
SH:Q-115	02-09-88	54.20	15.5	540	<0.10	<0.10
SH:Q-116	02-09-88	28.00	16.0	138	<0.10	<0.10
		LAKE COUNTY				
LK:E-022	02-25-88	17.40	14.0	300	--	--
LK:E-023	02-25-88	27.60	15.0	750	--	--
LK:F-001	02-24-88	40.00	14.5	750	<0.10	<0.10
LK:G-030	02-25-88	28.70	15.0	750	<0.10	<0.10
LK:H-005	02-25-88	26.90	14.5	400	<0.10	<0.10
LK:H-003	02-24-88	29.00	14.5	260	<0.10	<0.10
		OBION COUNTY				
OB:R-002	02-24-88	28.00	14.0	500	<0.10	<0.10

Table 3.--Triazine herbicide concentrations in sampled wells--Continued

Date	Simetryne total (ug/L) (39054)	Simazine total (ug/L) (39055)	Prometone total (ug/L) (39056)	Prometryne total (ug/L) (39057)	Atrazine, total (ug/L) (39630)	Alachlor total recover (ug/L) (77825)	Cyanzaine total (ug/L) (81757)	Ametryne total (82184)	Metribuzin water whole tot.rec (ug/L) (82611)	Metolachlor water whole tot.rec (ug/L) (82612)
					HAYWOOD COUNTY					
01-26-88	--	--	--	--	--	--	--	--	--	--
01-26-88	--	--	--	--	--	--	--	--	--	--
01-26-88	--	--	--	--	--	--	--	--	--	--
01-26-88	--	--	--	--	--	--	--	--	--	--
01-26-88	--	--	--	--	--	--	--	--	--	--
01-26-88	--	--	--	--	--	--	--	--	--	--
01-26-88	--	--	--	--	--	--	--	--	--	--
					SHELBY COUNTY					
02-09-88	--	--	--	--	--	--	--	--	--	--
02-09-88	--	--	--	--	--	--	--	--	--	--
02-09-88	--	--	--	--	--	--	--	--	--	--
02-09-88	<0.2	<0.20	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2
02-09-88	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1
02-09-88	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1
					LAKE COUNTY					
02-25-88	--	--	--	--	--	--	--	--	--	--
02-25-88	--	--	--	--	--	--	--	--	--	--
02-24-88	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1
02-25-88	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1
02-25-88	--	--	--	--	--	--	--	--	--	--
02-24-88	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1
					OBION COUNTY					
02-24-88	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1

REFERENCES

Gaydos, M.W., 1983, Results of pesticide sampling in Tennessee: U.S. Geological Survey Open-File Report 83-148, 22 p.

Madison, R.J., and Brunett, J.O., 1985, Overview of the occurrence of nitratelin groundwater of the United States, in National Water Summary: U.S. Geological Survey Water-Supply Paper 2275, 467 p.

Robbins, C.H., Garrett, J.W., and Mulderink, D.M., 1985, May 1984-April 1985 water budget of Reelfoot Lake with estimates of sediment inflow and concentrations of pesticides in bottom material in tributary streams--Basic data report: U.S. Geological Survey Open-File Report 85-498.

Skougstad, M.W., Rishman, M.J., Friedman, L.C., Erdmann, D.E., and Duncan, S.S. (eds.), 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter Al, p. 432-439.

Tennessee Agricultural Statistics Service, 1987, Tennessee Agricultural Statistics 1987: Nashville, Tennessee, Tennessee Agricultural Statistics Service.

Tennessee Division of Water Quality Control, 1977, Public Water System, in Rules of Tennessee Department of Public Health--Bureau of Environmental Health Services - Division of Water Quality Control: Tennessee Department of Pulic Health Services, Division of Water Quality Control, Chapter 1200-5-1, 29 p.

U.S. Environmental Protection Agency, 1986, Maximum contaminant levels (Subpart B of Part 141, National Interim Primary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, Revised July 1, 1986. p. 524-528.

Wershaw, R.L., Fishman, M.J., Grabbe, R.R., and Lowe, L.E. (eds.), 1983, Methods for the determination of organic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A3, p. 93-99.